CLAIMS:

1. A method of forming a semiconductor microstructure, the method comprising:

positioning a substrate in a process chamber;

flowing a process gas comprising an oxygen-containing gas in the process chamber; and

forming an oxide layer on the substrate, the layer being formed in a self-limiting oxidation process, wherein the partial pressure of the oxygen-containing gas in the process chamber is less than about 50 Torr.

2. The method according to claim 1, wherein the thickness of the oxide layer is less than about 15 A.

3. The method according to claim 1, wherein the thickness of the oxide layer is less than about 10 A.

4. The method according to claim 1, wherein the thickness uniformity of the oxide layer varies less than about 1 A over the substrate.

5. The method according to claim 1, wherein the substrate diameter is greater than about 195 mm.

6. The method according to claim 1, wherein the partial pressure of the oxygen-containing gas is less than about 40 Torr.

7. The method according to claim 1 wherein the oxygen-containing gas comprises O_2.

8. The method according to claim 7, wherein the process gas further comprises N_2.

9. The method according to claim 8, wherein the N_2:O_2 flow ratio is about 3:1.

10. The method according to claim 1, wherein the process gas further comprises an inert gas.

11. The method according to claim 10, wherein the inert gas comprises at least one of Ar, He, Ne, Kr, Xe, and N_2.

12. The method according to claim 1, wherein the substrate temperature is between about 500°C and about 1000°C.

13. The method according to claim 1, wherein the substrate temperature is about 700°C.

14. The method according to claim 1, wherein the substrate comprises Si and the oxide layer comprises SiO_2.

15. The method according to claim 1. wherein the process chamber pressure is less than atmospheric pressure.

16. The method according to claim 15, wherein the process chamber pressure is less than about 50 Torr.

17. A method of forming a semiconductor microstructure, the method comprising:

positioning a substrate containing an initial dielectric layer in a process chamber;

flowing a process gas comprising an oxygen-containing gas in the process chamber; and

forming an oxide layer with high thickness uniformity, the oxide layer being formed between the initial dielectric layer and the substrate in a self-limiting oxidation process, wherein the partial pressure of the oxygen-containing gas in the process chamber is less than about 50 Torr.

18. The method according to claim 17, wherein the initial dielectric layer comprises at least one of an oxide layer, an oxynitride layer, an nitride layer, and a high-k layer.

19. The method according to claim 18, wherein the oxide layer comprises SiO_2.

20. The method according to claim 18, wherein oxynitride layer comprises SiO_xN_y.

21. The method according to claim 18, wherein the nitride layer comprises silicon nitride.

22. The method according to claim 18, wherein the high-k layer comprises at least one of HfO_2, ZrO_2 , Ta_2O_5, TiO_2, Al_2O_3, and HfSiO.

23. The method according to claim 17, wherein the process chamber pressure is less than about 40 Torr.

24. The method according to claim 17, wherein the oxygen-containing gas comprises O_2.

25. The method according to claim 24, wherein the process gas further comprises N_2.

26. The method according to claim 17, wherein the process gas further comprises an inert gas.

27. The method according to claim 26, wherein the inert gas comprises at least one of Ar, He, Ne, Kr, Xe, and N_2.

28. The method according to claim 17, wherein the substrate temperature is between about 500° C and about 1000° C.

29. The method according to claim 17, wherein the substrate temperature is about 700°C.

30. The method according to claim 17, wherein the process chamber pressure is less than atmospheric pressure.

31. The method according to claim 17, wherein the process chamber pressure is less than about 50 Torr.

32. A microstructure comprising:

a substrate;

an oxide layer, the oxide layer being formed in a self-limiting oxidation process in a process chamber, wherein the partial pressure of an oxygen-containing gas in process chamber is less than about 50 Torr.

33. The microstructure according to claim 32, wherein a thickness of the oxide layer is less than about 15A.

34. The microstructure according to claim 32, wherein a thickness of the oxide layer is less than about 10A.

35. The microstructure according to claim 32, wherein the microstructure further comprises a high-k layer on the oxide layer; and

an electrode layer on the high-k layer.

36. The microstructure according to claim 35, wherein the high-k layer comprises at least one of HfO_2, ZrO_2 , Ta_2O_5, TiO_2, Al_2O_3, and HfSiO.

37. The microstructure according to claim 35, wherein the electrode layer comprises at least one of W, Al, TaN, TaSiN, HfN, HfSiN, TiN, TiSiN, Re, Ru, and SiGe.

38. A microstructure comprising:

a substrate;

an initial dielectric layer;

an oxide layer, the oxide layer being formed between the initial dielectric layer and the substrate in a self-limiting oxidation process, wherein the partial pressure of an oxygen-containing gas is less than about 50 Torr.

39. The microstructure according to claim 38, wherein a thickness of the oxide layer is less than about 15 A.

40. The microstructure according to claim 38, wherein a thickness of the initial dielectric layer is less than about 10 A.

41. The microstructure according to claim 38, wherein the initial dielectric layer comprises at least one of an oxide layer, an oxynitride layer, an nitride layer, and a high-k layer.

42. The microstructure according to claim 38, wherein the nitride layer comprises silicon nitride.

43. The microstructure according to claim 38, wherein the initial dielectric layer is formed in a self-limiting oxidation process.

44. The microstructure according to claim 38, the microstructure further comprising a high-k layer on the initial dielectric layer; and

an electrode layer on the high-k layer.

45. The microstructure according to claim 44, wherein the high-k layer comprises at least one of HfO_2, ZrO_2 , Ta_2O_5, TiO_2, Al_2O_3, and HfSiO

46. The microstructure according to claim 45, wherein the electrode layer comprises at least one of W, Al, TaN, TaSiN, HfN, HfSiN, TiN, TiSiN, Re, Ru, and SiGe.

47. A processing system comprising:

a process chamber;

a gas injection system configured to introduce a process gas in the process chamber, wherein the process gas comprises an oxygen-containing gas;

a substrate holder, the substrate holder exposes a substrate to the process gas in the process chamber, wherein an oxide layer is formed on the substrate in a self-limiting process, wherein the partial pressure of an oxygen-containing gas in the process chamber is less than about 50 Torr; and

a controller that controls the processing system.

48. The processing system according to claim 47, wherein process chamber comprises a batch type process chamber.

49. The processing system according to claim 47, wherein process chamber comprises a single wafer process chamber.

50. The processing system according to claim 47, further comprising a process monitoring system and a pumping system.

51. The processing system according to claim 47, wherein the substrate comprises Si and the oxide layer comprises SiO_2.

52. The processing system according to claim 47, wherein the substrate further comprises an initial dielectric layer.

53. The processing system according to claim 52, wherein the oxide layer is formed between the initial dielectric layer and the substrate.

54. The processing chamber according to claim 47, wherein the substrate holder is adapted to hold substrates having a diameter greater than about 195 mm.